

Multi-Platform, Multi-Architecture Runtime Verification of Autonomous Space Systems

Completed Technology Project (2016 - 2019)



Project Introduction

Autonomous systems are only capable of effective self-governing if they can reliably sense their own faults and respond to failures and uncertain environmental conditions. We propose to design a real-time, onboard runtime verification and system health management (SHM) framework called R2U2, to continuously monitor essential system components such as sensors, software, and hardware for detection and diagnosis of failures and violations of safety or performance rules during the mission of autonomous space systems, such as rovers, small satellites, or Unmanned Aerial Systems (UAS) flying in the skies of other planets. R2U2 is multi-platform and multi-architecture to address the requirements and capabilities of these embedded systems. R2U2 stands for Responsive, Realizable, Unobtrusive Unit; it is named after its three crucial properties that are currently absent from state-of-the-art SHM capabilities. Responsiveness means evaluating system health in real time, with provable timing and performance guarantees. Realizability involves being adaptable, extensible, and scalable to multiple platforms and architectures. Unobtrusiveness requires R2U2 to operate without altering crucial properties of the system: functionality, certifiability, timing, or tolerances for size, weight, power, telemetry bandwidth, software overhead. A full-scale version of R2U2, with options for hardware- and software-based implementations would have tremendous impact on the ability of autonomous space systems to perform real-time system-level reasoning about their health.

Anticipated Benefits

A full-scale version of R2U2, with options for hardware- and software-based implementations would have tremendous impact on the ability of autonomous space systems to perform real-time system-level reasoning about their health.



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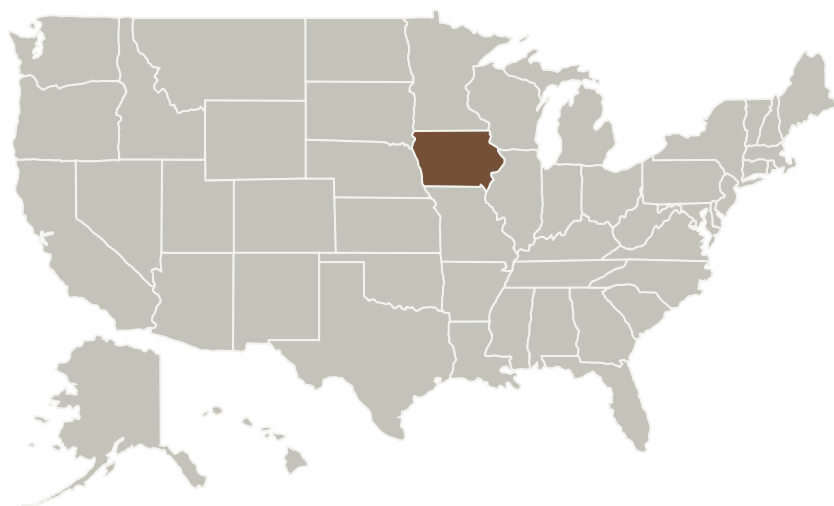
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Iowa State University	Lead Organization	Academia	Ames, Iowa

Primary U.S. Work Locations

Iowa

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Iowa State University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

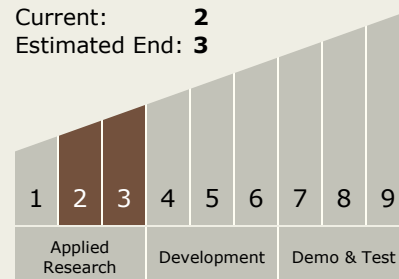
Hung D Nguyen

Principal Investigator:

Kristin Y Rozier

Technology Maturity (TRL)

Start: 2
Current: 2
Estimated End: 3



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Technology Areas

Primary:

- TX10 Autonomous Systems
 - └ TX10.4 Engineering and Integrity
 - └ TX10.4.3 Operational Assurance of Autonomous Systems

Target Destination

Foundational Knowledge